NuMI

MINOS

NuMI Project Overview

NuMI Project Overview

Greg Bock

AAC Meeting
November 17 , 2004
Fermilab

- Introduction
- Progress last year
- Summary and Outlook
- NuMI Commissioning (Baller) and Main Injector Commissioning (Marchionni) talks will follow the tour after lunch

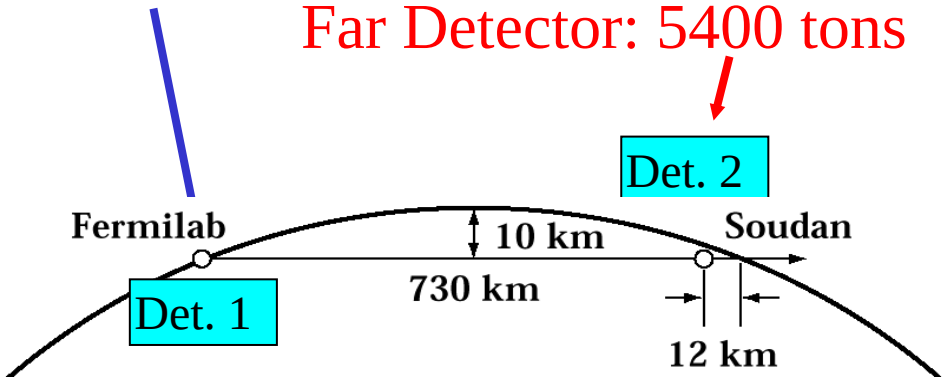
NuMI Project

Construct Facilities and Equipment for a Two Detector Neutrino Oscillation Experiment with Variable Energy Neutrino Beam (Start 2005)

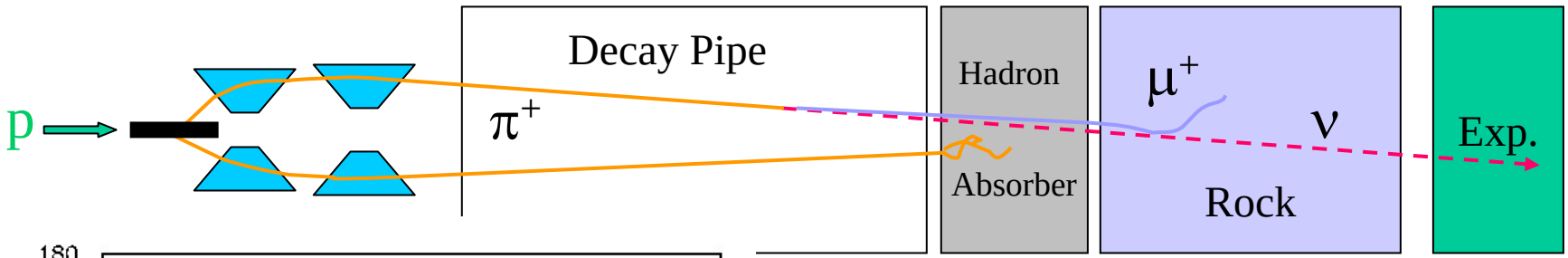
Obtain firm evidence for oscillations and measure oscillation parameters, Δm^2, $\sin^2 2\theta$. Probe for $\nu_\mu \rightarrow \nu_e$ appearance.

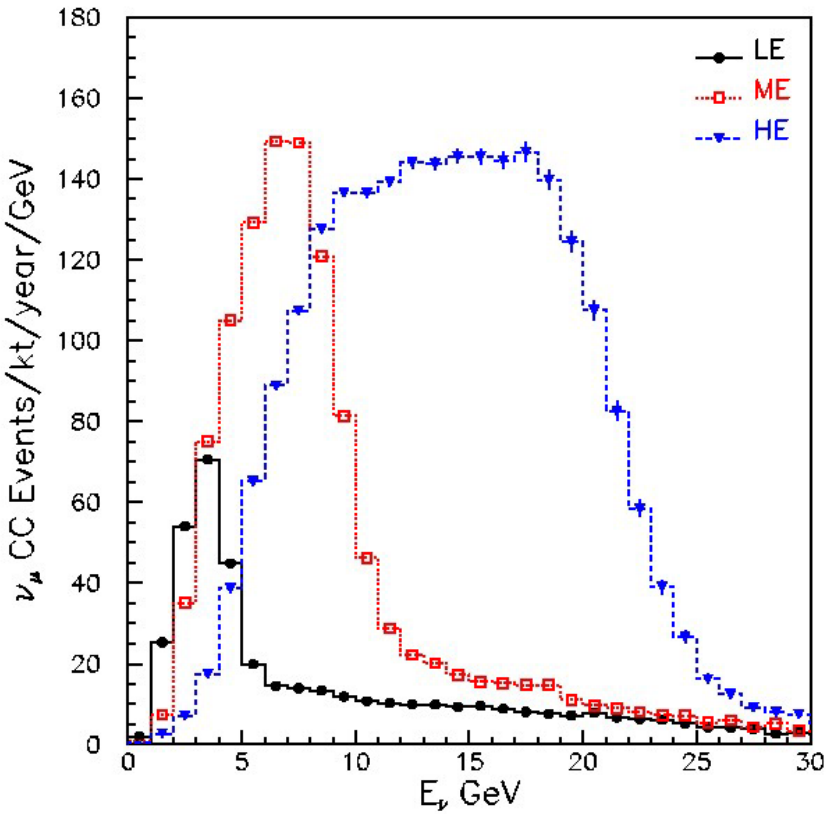
Near Detector: 980 tons

Far Detector: 5400 tons



NuMI Scientific and Technical Facilities at Fermilab



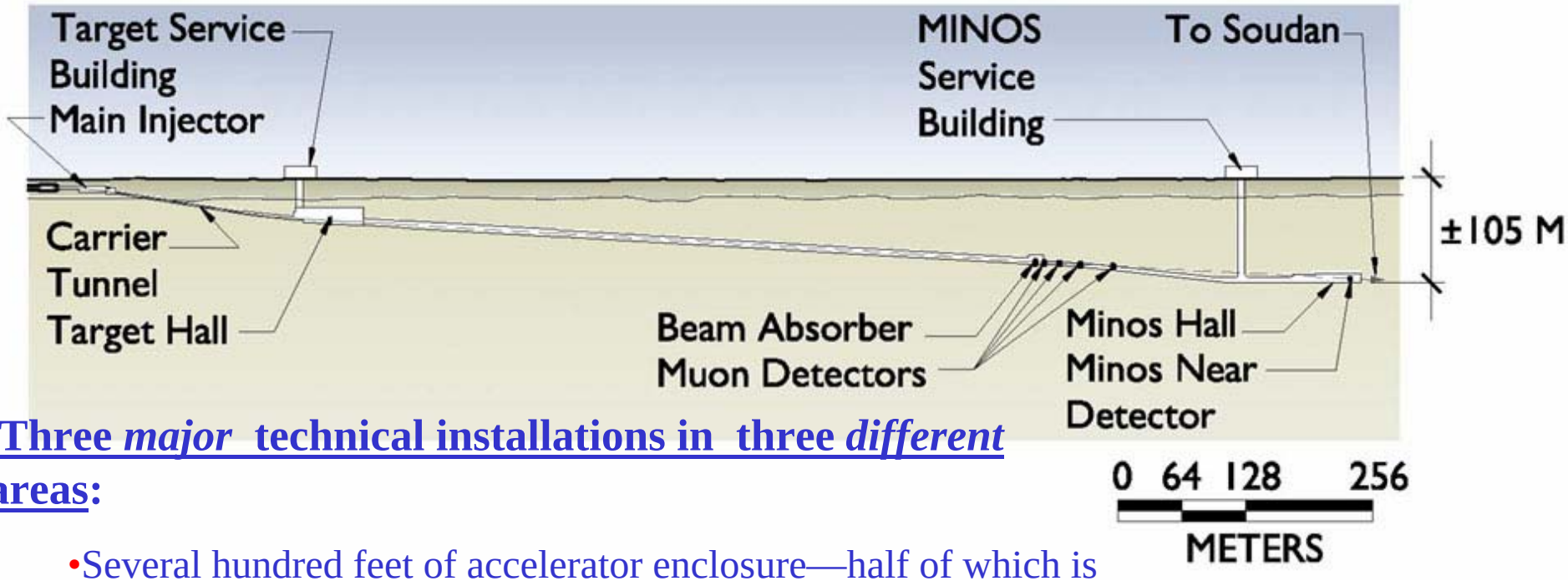


Expected CC Events Rates in MINOS Far detector

- «High 8,000 ev/2E20 p
- «Medium 3,600 ev/2E20 p
- «**Low 1,400 ev/2E20 p**

(OFF-AXIS Beams come for free)

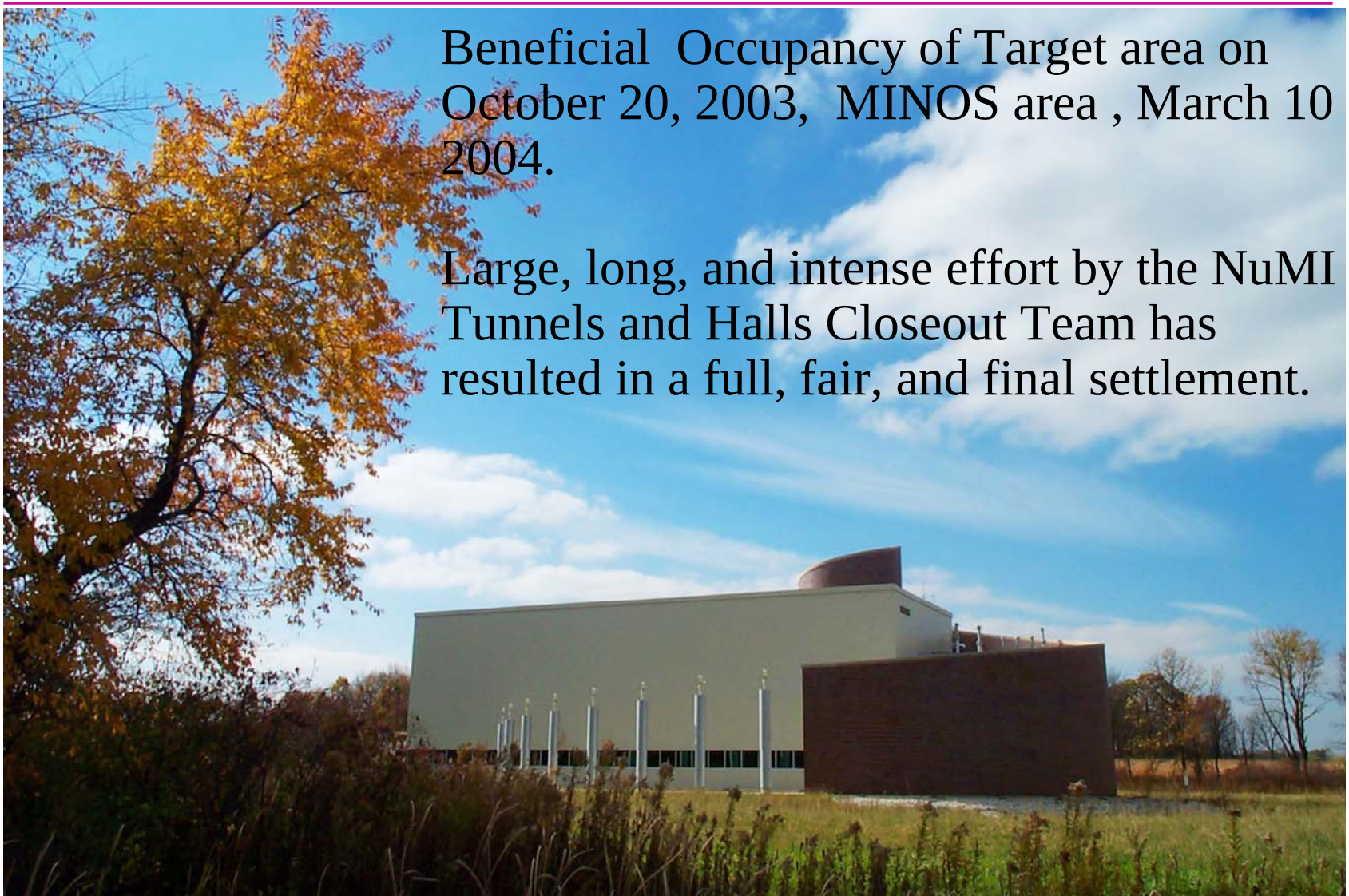
NuMI Facilities and Installation at Fermilab



Three *major* technical installations in three *different* areas:

- Several hundred feet of accelerator enclosure—half of which is between two operating machines
- Downstream end of carrier tunnel, Pre-Target and Target Areas--primary beam focus, 8KT neutrino beam target station
- MINOS area—beam monitoring, ~1 KT hadron absorber and ~ 1 KT neutrino detector

Conventional Facilities are COMPLETE



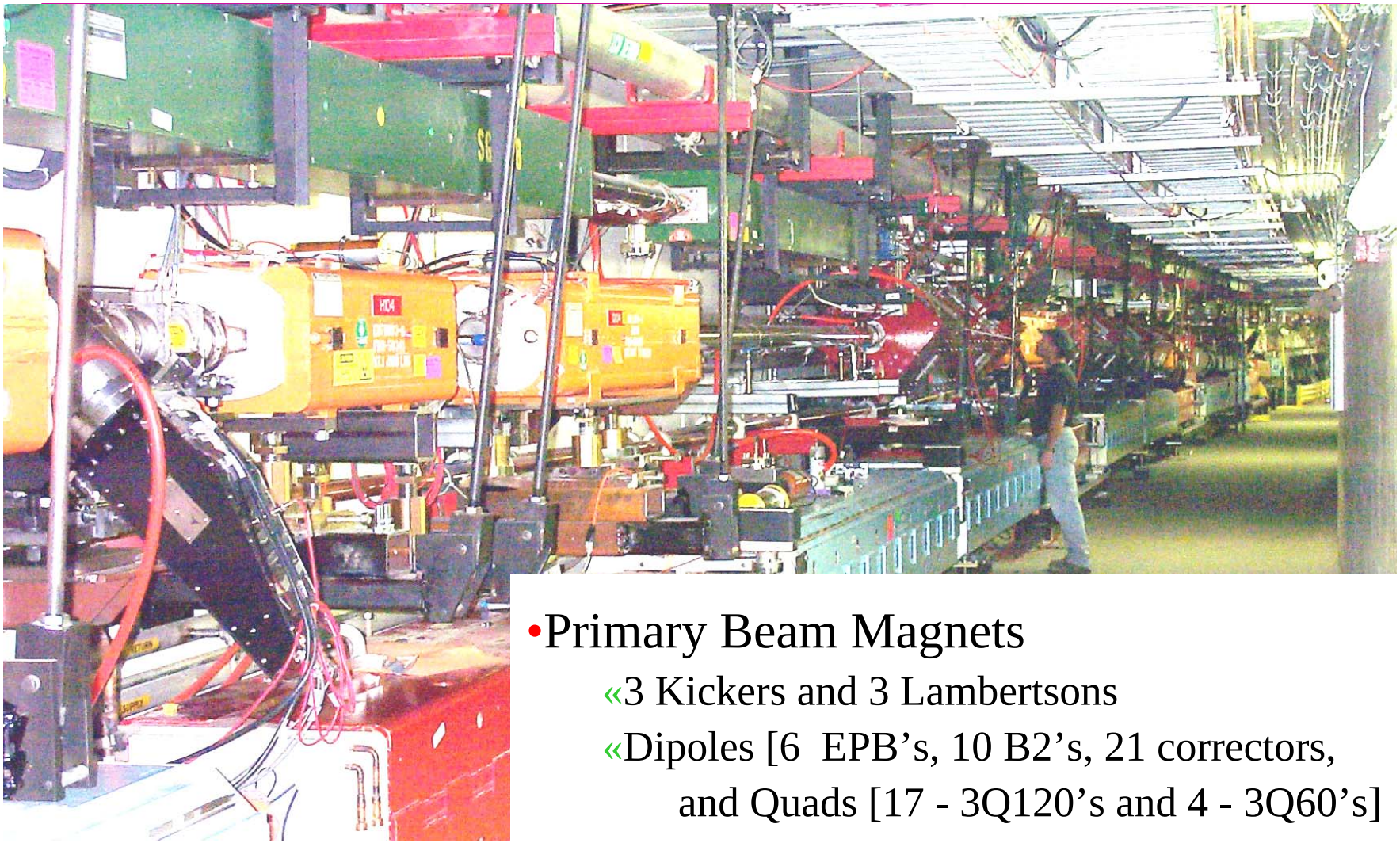
Beneficial Occupancy of Target area on October 20, 2003, MINOS area , March 10 2004.

Large, long, and intense effort by the NuMI Tunnels and Halls Closeout Team has resulted in a full, fair, and final settlement.

Status of Technical Components and Near Detector

- **We have moved from installation to pre-commissioning.**
  - Major intra-laboratory effort AD, PPD, TD especially in recent accelerator enclosure installation. BSS, CD, ES&H, and FESS provide vital support .
- **Technical Components**
  - Shutdown work on schedule and nearly complete.
  - Worked well with other accelerator systems departments (Main Injector,Recycler, Proton Source) and have integrated the NuMI beam into the accelerator complex installation and operation.
  - Collaboration is an active, crucial part of this effort, with probably a dozen members embedded in what is traditionally a Lab effort
- **Near Detector**
  - 281 Planes installed and commissioned underground over the summer
  - Coil to be energized in a couple weeks
  - Routine cosmic ray data underway

Main Injector



- Primary Beam Magnets
  - 3 Kickers and 3 Lambertsons
  - Dipoles [6 EPB's, 10 B2's, 21 correctors, and Quads [17 - 3Q120's and 4 - 3Q60's]

Pre-Target Area

- INSTRUMENTATION
  - «Beam Position Monitors - 24
  - «Profile Monitors – 10
  - «Intensity Monitors – 2
  - «Beam Loss Monitors – 53
  - «Resistive Wall Monitor
  - «OTR Monitor – 1

Primary Beam Status

- All primary beam components installed and initial alignment complete
- Power supply testing and instrumentation checkout ongoing
- Vacuum system nearly complete
- Final alignment on schedule
- Have requested initial NuMI extracted beam 1st week of December!

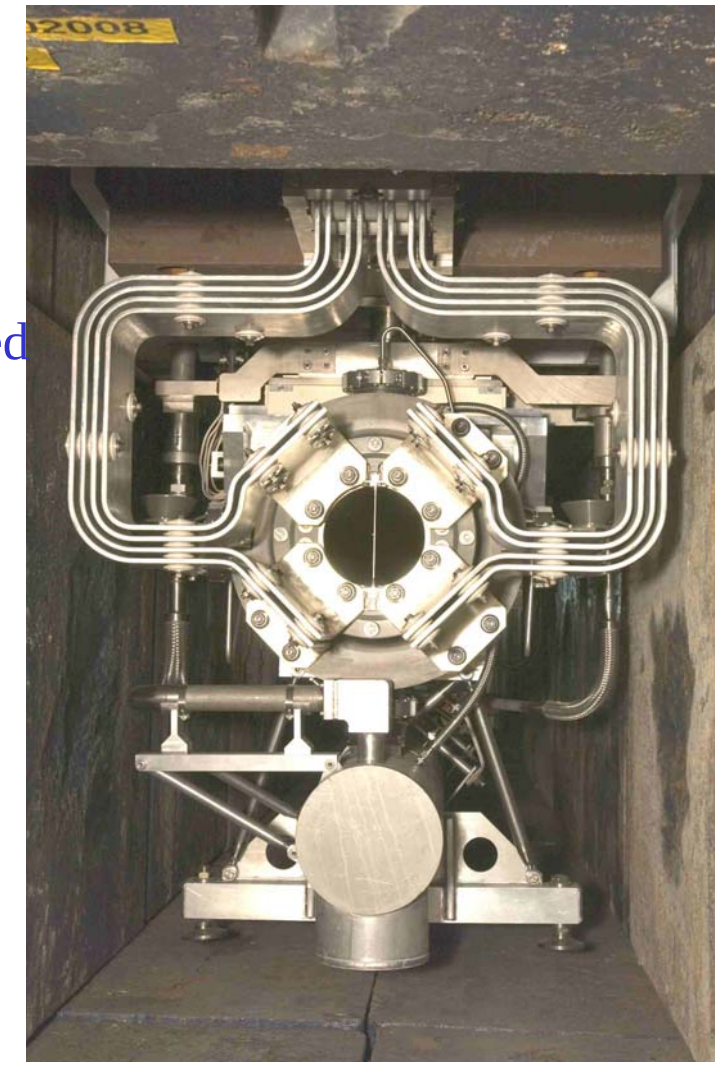
Target Station Status

-Target in place

-Utilities connected

-Horns have been Pulsed

-8KT of stuff



More Neutrino Beam Status

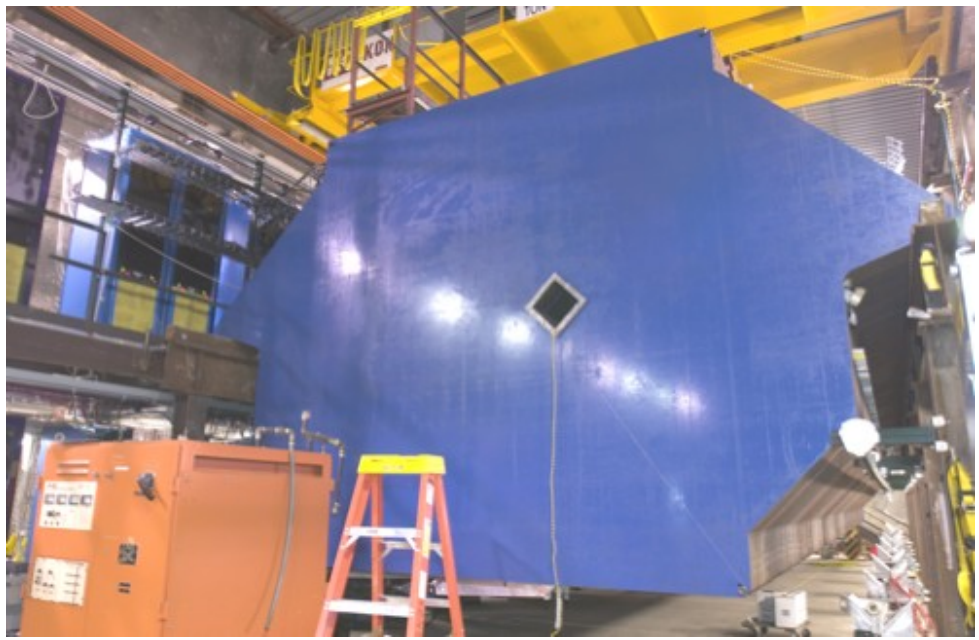
Work Cell/Horn Handling

- Remaining Target Pile work:
  - Air handling installation
  - Radioactive handling practice
  - Shielding top-off
- Vacuum Decay region complete and tested
- Hadron Absorber complete (1KTon Al/Fe/Concrete)
- Neutrino Beam Monitoring installation complete in a day or so

The MINOS Detectors

(Collecting cosmic ray muons. Ready for beam today)

- Far Detector (Soudan Lab)
  - 8m Octagonal Tracking Calorimeter
  - 2 sections, 15m each
  - 486 planes of steel & scintillator
  - 95,000 scintillator strips
  - **5.4 kT total mass**
- Near Detector (MINOS Hall - FNAL)
  - 3.8 x 4.8m “octagonal” tracking calorimeter
  - Same basic construction, sampling & response as the far detector
  - 282 planes of steel
  - 153 planes of scintillator
  - **980 ton total mass**



Near Detector Installation

CD4 Commissioning and the Transition to Operations

- Commissioning Plan for Project Completion (“CD4”)
  - Demonstrate a functioning Far Detector (atmospheric neutrinos and muons)
  - Demonstrate a functioning Beamline and Near Detector (with beam neutrinos)
- Commissioning for Physics
  - 2.5E13 protons , 5/6 batches, 5E12 in Booster , 2 s cycle
  - Multi-batch studies, dampers, beam loading compensation, booster shielding, booster notch and timing, RF work
  - Integrated into AD/HQ planning: tasks, people, studies
  - Commissioning workshops and meetings with AD systems and operations departments
  - Primary Beam shakedown planned for December

Main Injector Status

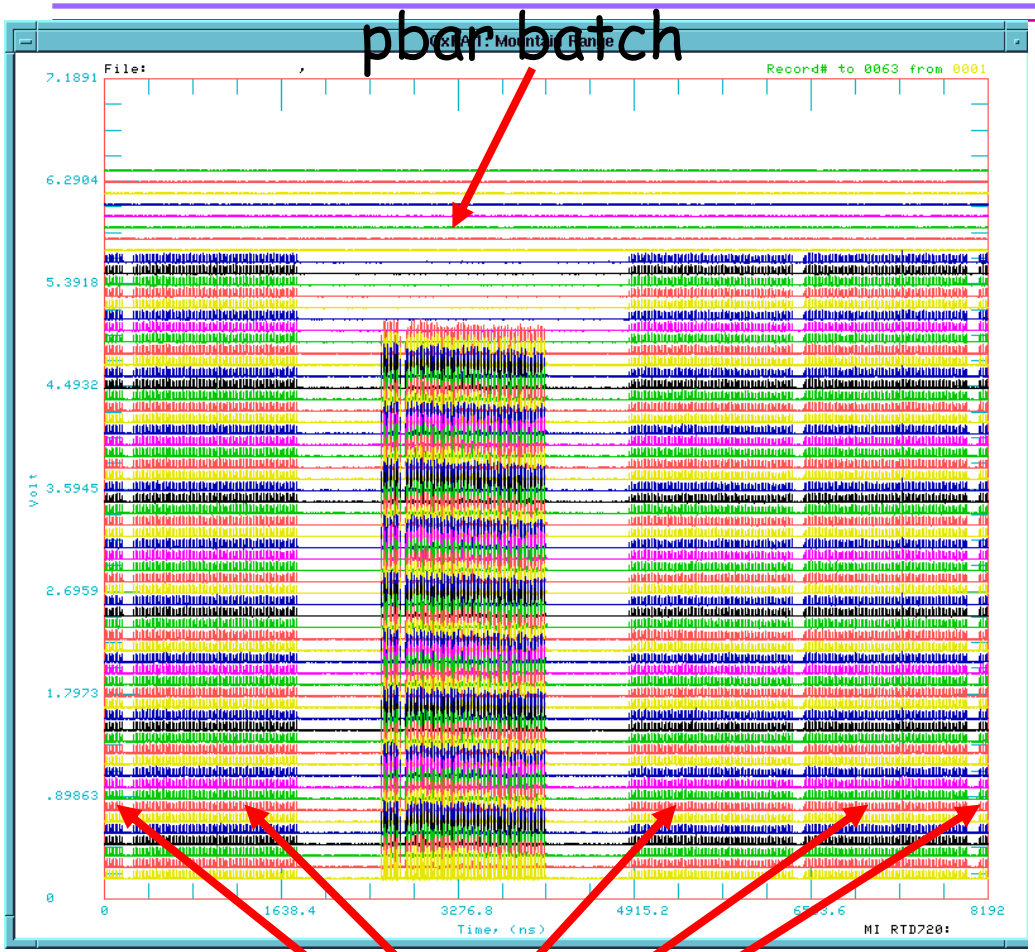
- All operational issues **OK for initial NuMI commissioning**
  - MI beam permit inputs need attention
  - we need to test the newly developed cycle combining slip-stacking and NuMI multi-batch

- Achieved a max intensity of 2.9×10^{13} protons @ 120 GeV in MI, but …
  - more work needed on the damper system
  - beam losses and beam quality issues still to be worked on above ~1.5×10^{13} protons
  - still working on residual RF problems
- Enough time at startup to fix residual problems in Booster cogging (notcher, GMPS compensation)

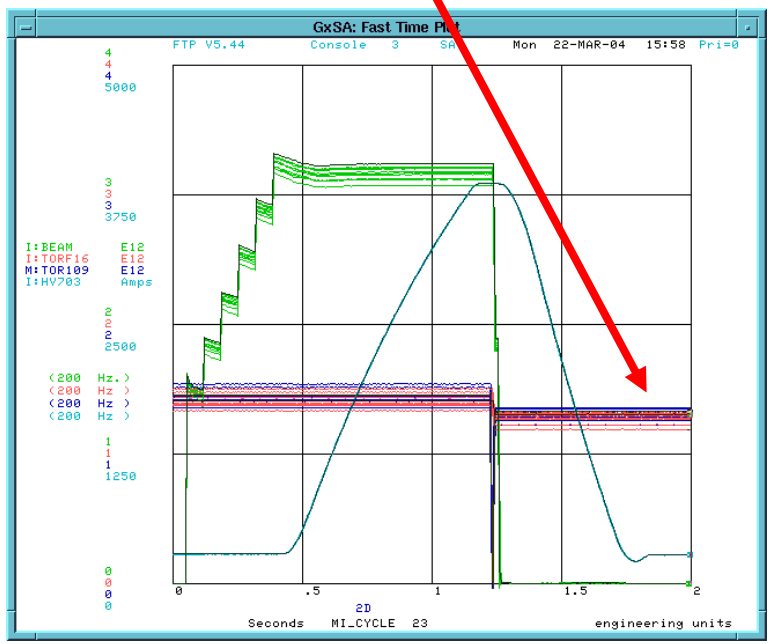
Multi-batch Study

G. Bock
Accelerator Advisory Committee
November 17, 2004

pbar batch



Beam on the pbar target



NuMI batches

Environment, Safety, and Health

- Safety across the project remains uppermost on all our minds. Our deep underground facility is unique at Fermilab.
- Our safety plan emphasizes Fermilab's safe work policies. Throughout the project we are taking time to plan ahead, identify hazards, put controls in place, monitor, assess, and correct.
- Maintaing dedicated ESH staff, walk throughs continue. Weekly meetings with ES&H and project senior staff continue.
- 2 Injuries during installation--a hernia and a head laceration.
- ES&H reviews completed. Joint AD/PPD Safety Committee provides oversight.
- The review of the NuMI Shielding Assessment (SA) and Safety Assessment Document (SAD) by the DOE Accelerator Readiness Review (ARR) Support Team has been successfully completed.
- Both the NuMI SA and SAD have been approved by the director.
- The kick-off meeting for the Fermilab ARR Committee will be held mid November with an eye to completion near the end of November. We are on schedule for December beam.

Underground Tours

- NuMI underground tours are a major attraction:
  - Overseers, employees, users, contractors, conference attendees, neighbors, relatives…..
- Variety of tour packages (safety briefing and hardhat included) :
  - 'Budget Tours' of one area (40 minutes)
  - 'Top of the Line' walk from pretarget to ND (1.5 hours)
  - 'Executive Grand Tour' from Main Injector through to MINOS
- About 1000 (!) people have been underground
- Education Office support has been crucial --(used theorists as guinea pigs and Ramberg helped us get going)
- NuMI project staff have really made an effort beyond the call of duty

Cost Table ($K)
September 30, 2004

WBS		Amount Authorized	Estimated Cost	ETC (BAC - BCWP)	% Complete	Obligated $	Obligated %
As of September 30, 2003							
TEC		109,168	107,360	778	99%	107,066	100%
	1.1 (Beamline)	29,277	747		97%	29,414	100%
	1.2 (Facility)	74,652	0		100%	74,588	100%
	1.3 (Management	3,431	31		99%	3,064	89%
OPC		62,200	59,301	167	100%	59,204	100%
	2.0 (Detectors)	43,153	167		100%	43,062	100%
	3.0 (Soudan)	16,148	0		100%	16,142	100%
TPC		171,368	166,661	945	99%	166,270	100%

Sept 02 Report Numbers:
71% complete, $45M to go

Sept 03 Report Numbers:
92% complete, $13M to go

Summary

- Conventional Facility construction is complete!
- 10,000 tons of stuff installed last year!
- Both Near and Far detectors are ready for beam right now, and we are running them from the 12th floor control room.
- Beamline installation nearly done, checkouts and dry runs and pre-commissioning underway as planned
- FMI commissioning underway as planned
- Over $11M of earned value in last year. Some contingency will remain.
- A major effort by the Laboratory and Collaboration along with continued support from the DOE.

Outlook

- First commissioning with protons in 3 weeks.
- Forecasting official Project Completion (CD4) on February 1, 2005, just over 2 months from now. (3 days earlier than we predicted last year)
- MINOS Physics data beginning in early Spring.